SNS Linac Technical Memo

Faraday Cup
Outgassing Rate

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4/4/2001

WBS 14.5.2.? (Diagnostics – Faraday Cup)

Vacuum Loads for SNS Faraday Cup

Summary : In order to do the initial design of the D-plate vaccuum system a calculation was done to estimate the out-gassing load from the Faraday Cup. The Faraday Cup for the D-plate is being developed under WBS 1.4.5.2.?, since it will be used elsewhere in the accelerator. Also note that as the designs of these devices become more mature, the responsible person should update these values and pass the information on to the vacuum system designers, especially if the new values exceed these presented here.

The assumptions made were:

Device is mounted on a linear actuator similar to the wirescanner.

Kapton insulated wires are used to bring the signals out from the vacuum.

Copper water cooling lines are also used.

Conclusion

The estimated out-gassing rate for the Faraday Cup is 1.835 x 10^-7 torr*L/s

Inner surfaces exposed to vacuum:

$d := 3 \cdot cm$

$d = 1.181 in$

$t_{foil} := .0025 \cdot in$

$t_{cup} := 0.013 \cdot in$

$$C_{cup} := \frac{\pi \cdot d^2}{4} + \pi \cdot d \cdot t_{cup}$$

$C_{cup} = 7.38 cm^2$

$t_{plate} := 0.25 \cdot in$

$$Cu_{plate} := \frac{\pi \cdot d^2}{4} + \pi d \cdot t_{plate}$$

$$Cu_{plate} = 13.053\,cm^2$$

Estimate the amount of copper tubing exposed to the vacuum

$$d_{tubing} := 0.25 \cdot in$$

$$L_{tubing} := 36 \cdot in$$

$$Cu_{tubing} := \pi \cdot d_{tubing} \cdot L_{tubing}$$

$$Cu_{tubing} = 182.415\,cm^2$$

$$Cu_{total} := Cu_{plate} + Cu_{tubing}$$

$$Cu_{total} = 195.468\,cm^2$$

Signal wires, assuming .024" diameter Kapton insulated wires.

$$Wire_{SA} := 6 \cdot 24 \cdot in \cdot \pi \cdot .024 \cdot in$$

$$Wire_{SA} = 70.047\,cm^2$$

$$Wire_{SA} = 10.857\,in^2$$

The following values are based on a design similar to the wire scanner.

$$Guide\_rail_{SA} := 19.91\,in^2$$

$$Guide\_rail_{SA} = 128.451\,cm^2$$

$$Support_{SA} := 84.1 \cdot in^2$$

$$Support_{SA} = 542.58\,cm^2$$

$$Tube_{SA} := \pi \cdot (.625 \cdot in + .375 \cdot in) \cdot 14.2\,in$$

$$Tube_{SA} = 287.81\,cm^2$$

$$Bellows_{SA} := \frac{\pi}{4} \cdot \left[(2.2 \cdot in)^2 - (1.04\,in)^2 \right] \cdot 12 \cdot 2$$

$$Bellows_{SA} = 457.058\,cm^2$$

$$Box_{SA} := \pi \cdot 1.5\,in \cdot 3\,in$$

$$Box_{SA} = 91.207\,cm^2$$

Outgassing rate of exposed surfaces

$$LR_{ss} := 1 \cdot 10^{-10} \cdot \frac{torr \cdot L}{s \cdot cm^2}$$

$$LR_{Cu} := LR_{ss}$$

$$LR_C := 1.736 \cdot 10^{-8} \cdot \frac{torr \cdot L}{s \cdot cm^2}$$

Total outgassing of stainless and copper parts is:

$$OGR_{ss} := LR_{ss} \cdot \left(Cu_{total} + Guide\_rail_{SA} + Support_{SA} + Tube_{SA} + Bellows_{SA} + Box_{SA} \right)$$

$$OGR_{ss} = 1.703 \times 10^{-7} \frac{torr \cdot L}{s}$$

Outgassing rate as measured by Virgo

$$LR_{kapton} := 8.36 \cdot 10^{-11} \cdot \frac{torr \cdot L}{s \cdot cm^2}$$

$$OGR_{kapton} := Wire_{SA} \cdot LR_{kapton}$$

$$OGR_{kapton} = 5.856 \times 10^{-9} \frac{torr \cdot L}{s}$$

Seals and their leak rates

$$Bellows := 2 \cdot 10^{-9} \cdot \frac{torr \cdot L}{s}$$

$$conflat := 1 \cdot 10^{-10} \cdot torr \cdot \frac{L}{s}$$

$$viton := 5 \cdot 10^{-9} \cdot torr \cdot \frac{L}{s}$$

Total leak rate of the faraday cup is:

$$OGR_{FC} := OGR_{ss} + Bellows + 4 \cdot conflat + viton + OGR_{kapton}$$

$$OGR_{FC} = 1.835 \times 10^{-7} \frac{torr \cdot L}{s}$$